

Landsat data continuity: advanced radiometric characterization and product development

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Landsat Science Team Meeting

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South Dakota State University
Image Processing Lab

SDSU Image Processing Lab

- **Purpose:** Radiometric, Geometric, and Spatial Characterization, Correction, and Calibration of Satellite and Airborne Imaging Systems.
- Began with a cold phone call to EROS Data Center in 1988...
- Founded in 1990
 - 1 graduate student, 1 Sun 3/80 workstation
 - 12-15 working in the lab these days



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Landsat data continuity: advanced radiometric characterization and product development

- Landsat data continuity—entering the Landsat 8 era with new spectral opportunities
- Vicarious calibration using Pseudo Invariant Calibration Sites (PICS): trending and absolute
- Landsat data continuity—improving the historical record's calibration



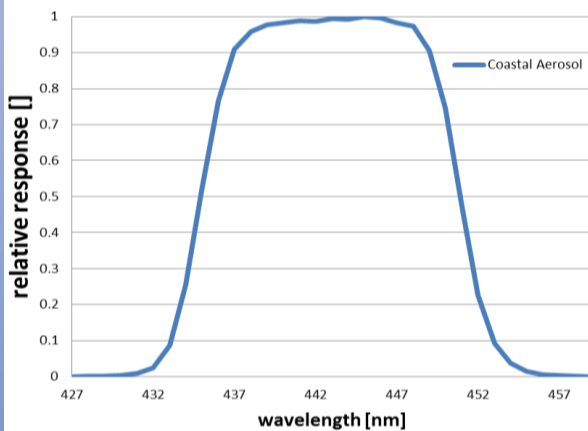
Objective: Seamless data continuity from Landsat 7 to Landsat 8

- Spectral bands—similar but different, less atmospheric influence
- New calibration opportunities

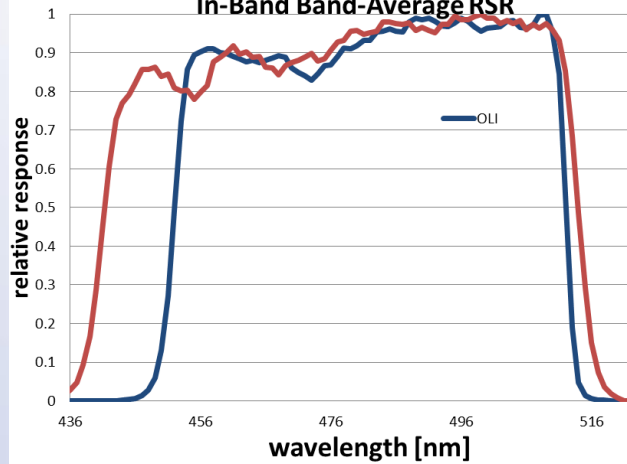
LANDSAT DATA CONTINUITY—ENTERING THE LANDSAT 8 ERA WITH NEW SPECTRAL OPPORTUNITIES



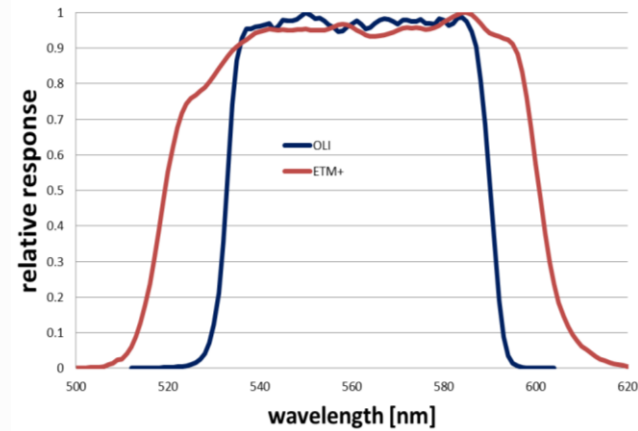
OLI Coastal/Aerosol Band
In-Band Band-Average RSR



Blue Band
In-Band Band-Average RSR

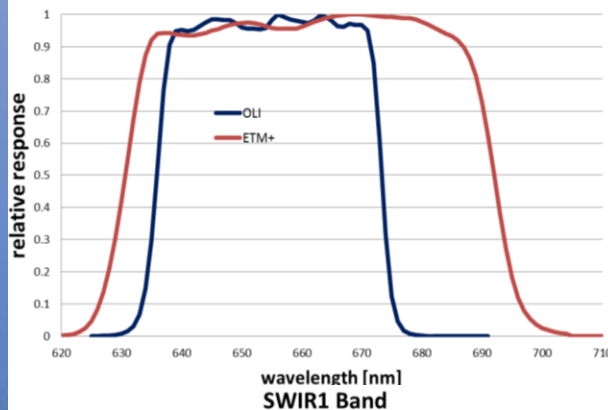


Green Band
In-Band Band-Average RSR



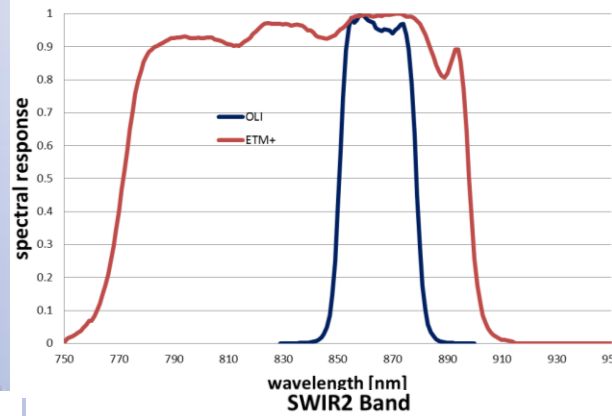
Red Band

In-Band Band-Average RSR

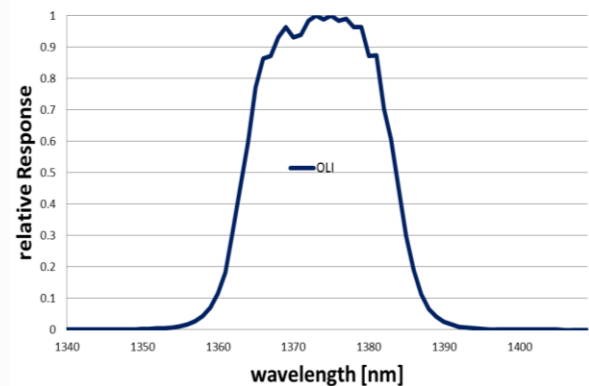


NIR Band

In-Band Band-Average RSR

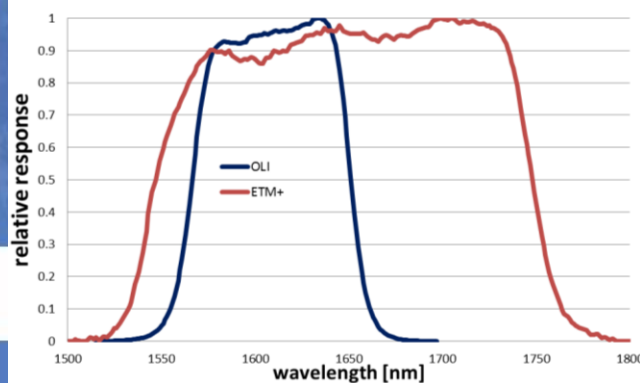


OLI Cirrus Band
In-Band Band-Average RSR



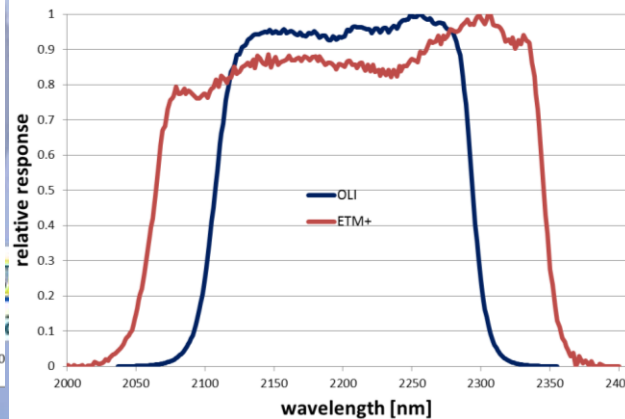
SWIR1 Band

In-Band Band-Average RSR



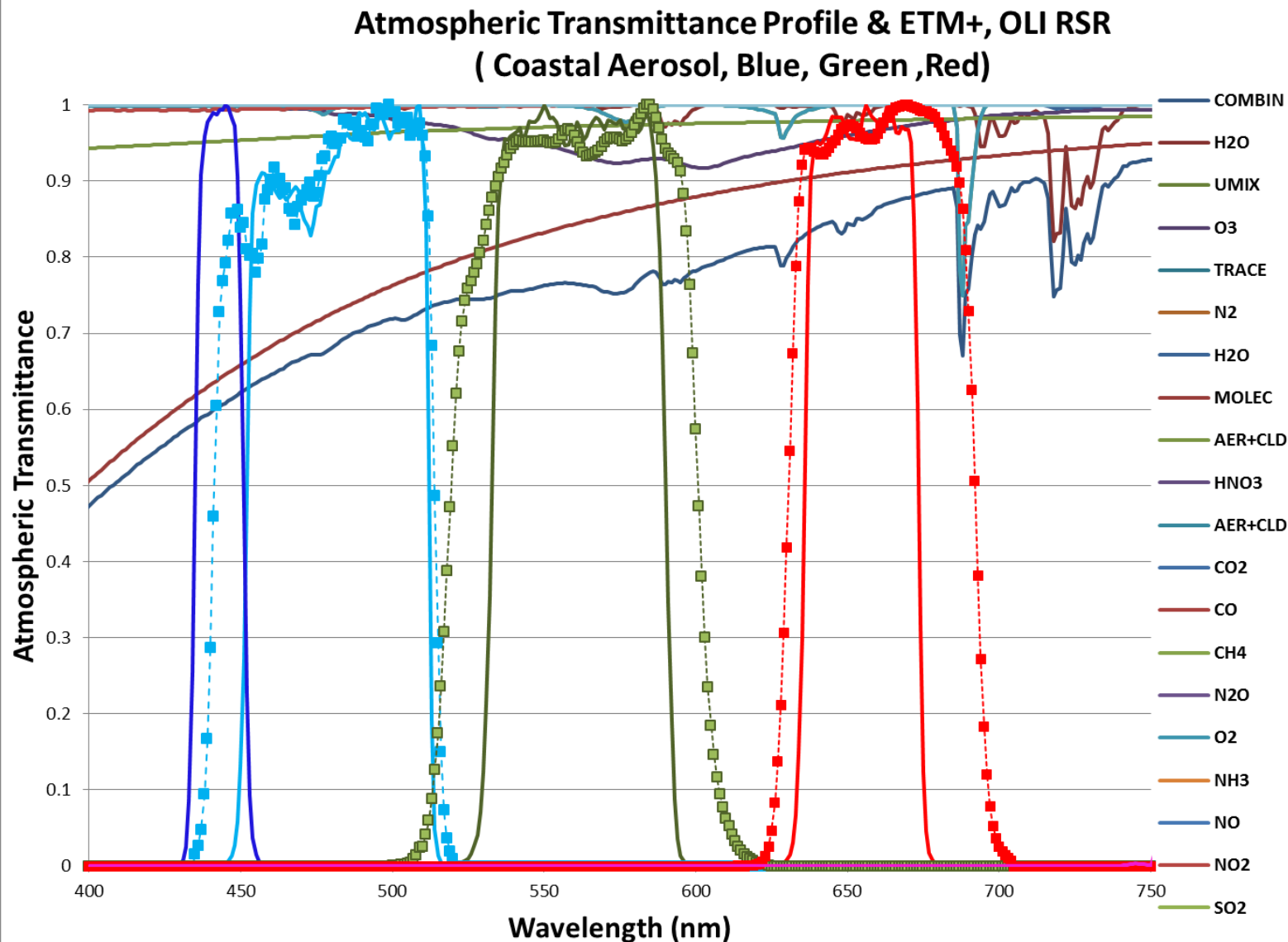
SWIR2 Band

In-Band Band-Average RSR

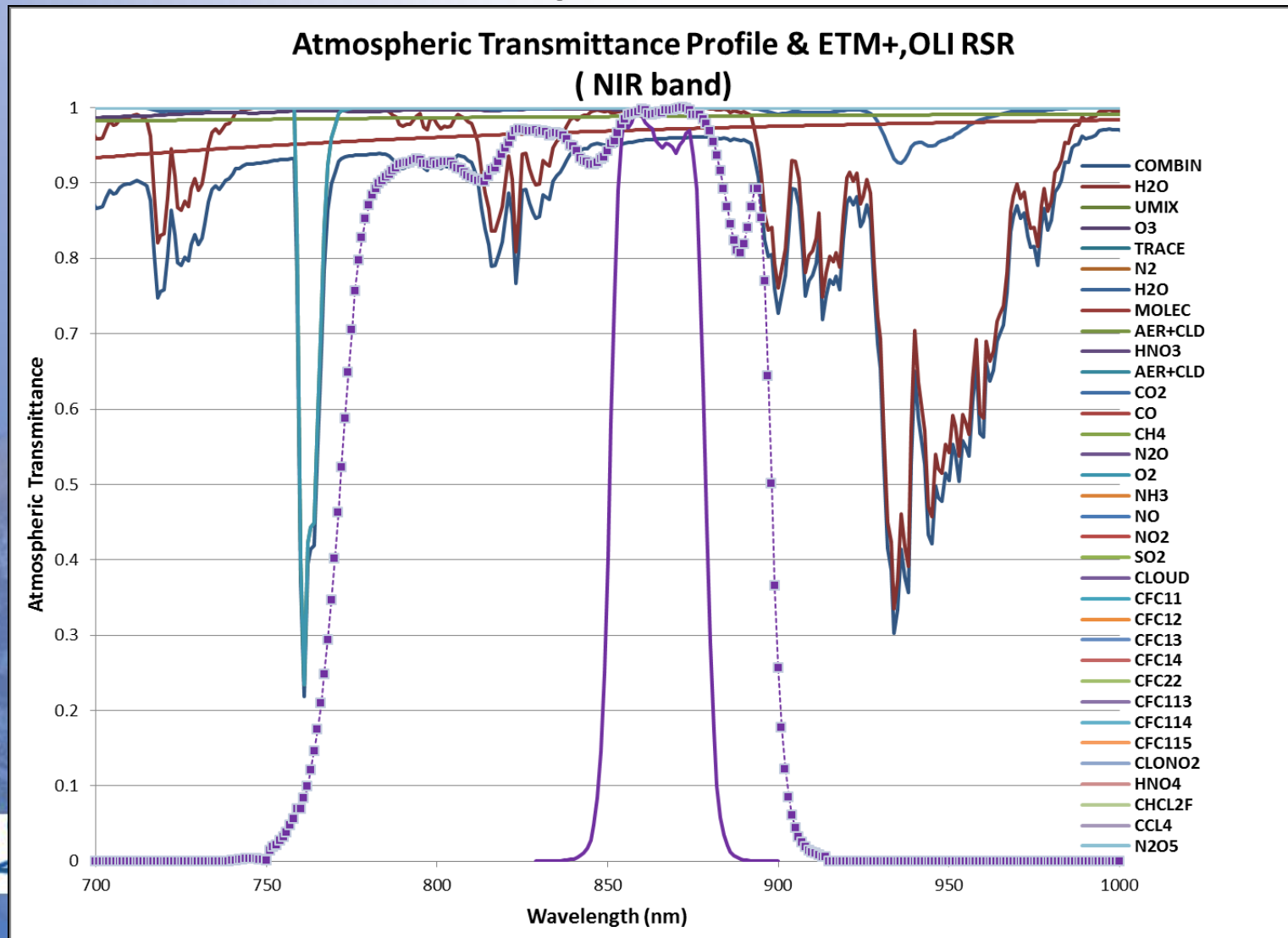


In all cases narrower spectral bands, but higher SNR!

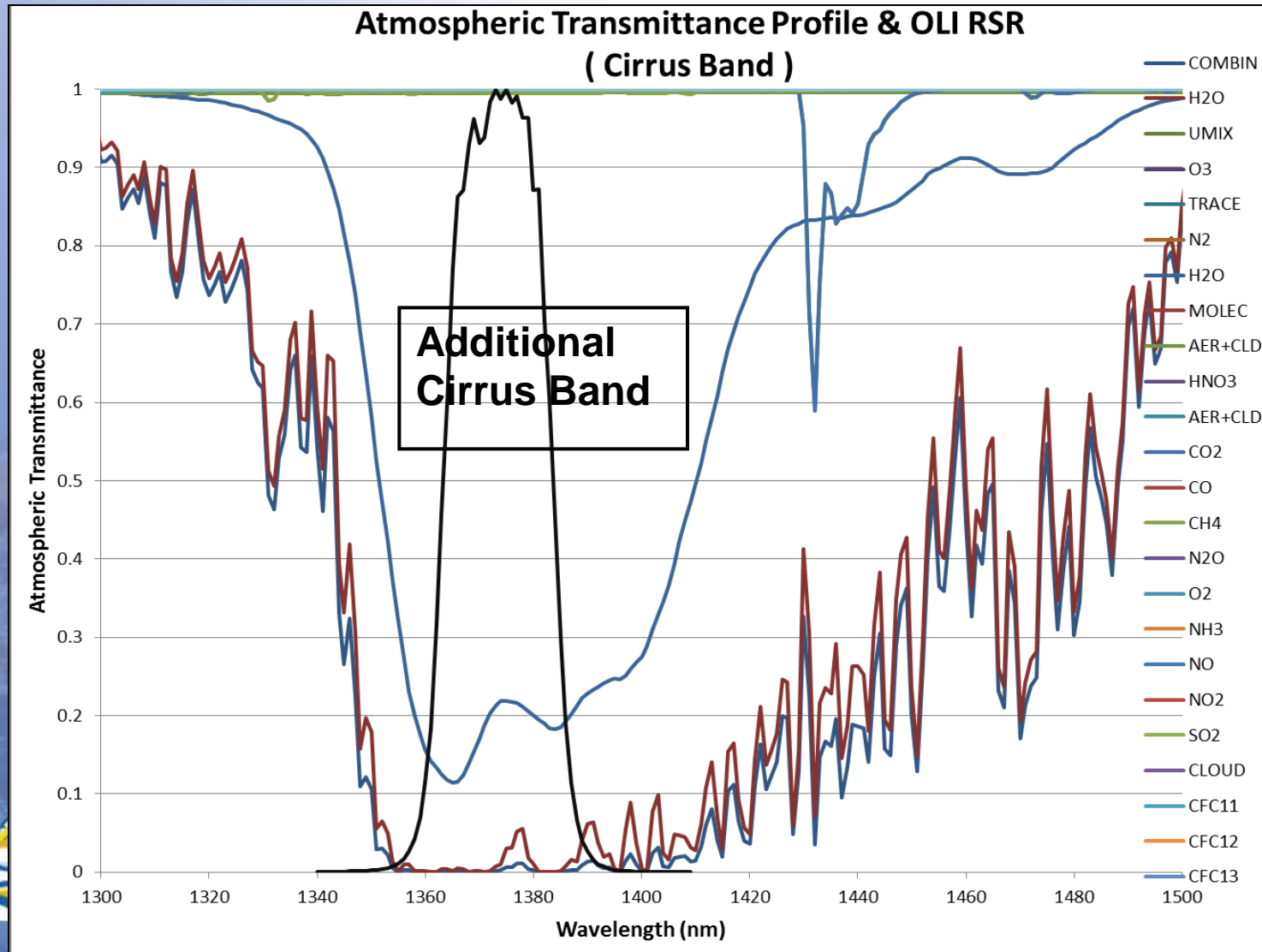
OLI, ETM+ RSRs and spectral transmittance profiles



OLI NIR band avoids water vapor absorption feature

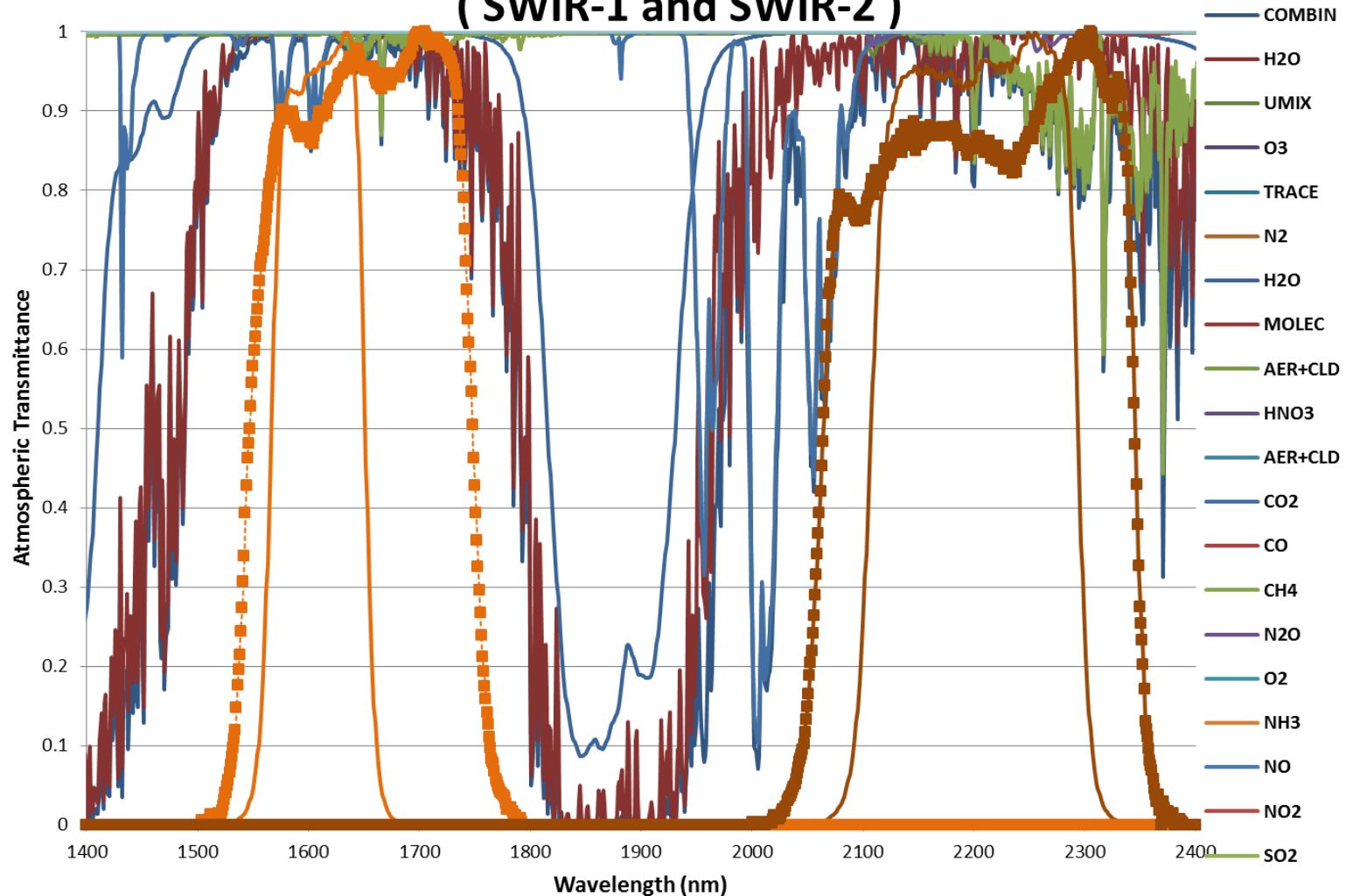


Cirrus Band



SWIR channels

Atmospheric Transmittance Profile & ETM+, OLI RSR
(SWIR-1 and SWIR-2)

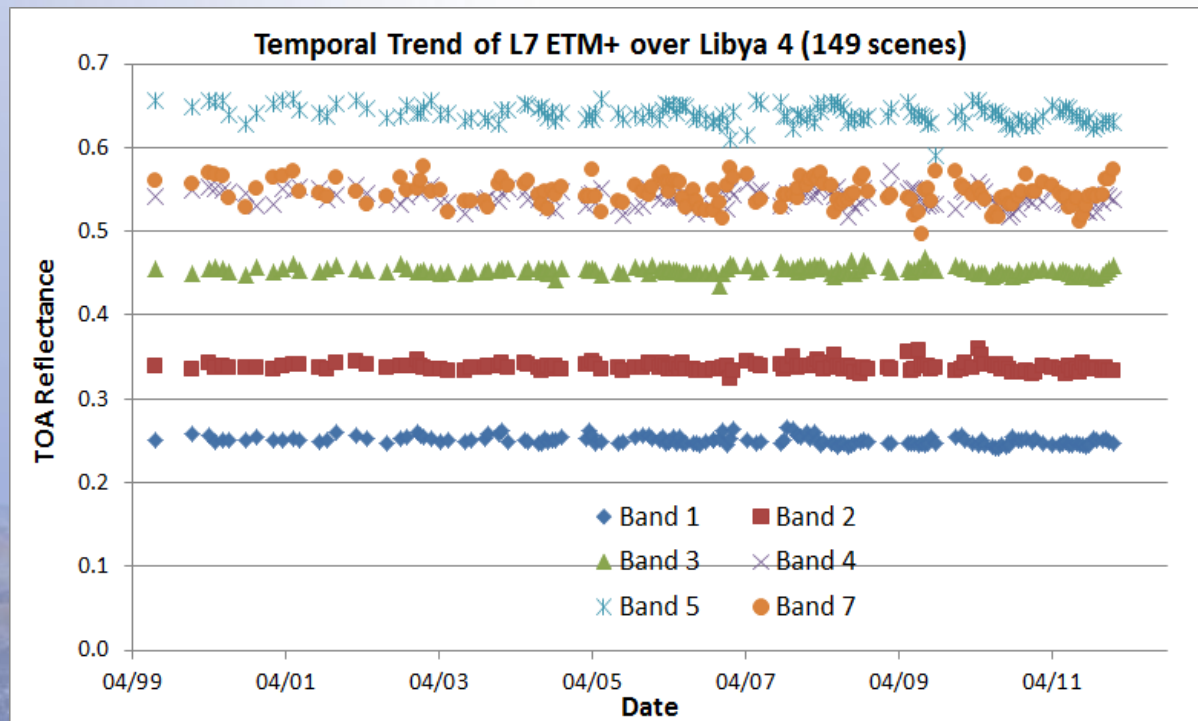


Objective: Improved vicarious calibration—both relative and absolute

- Higher precision and accuracy
- Complements onboard systems

VICARIOUS CALIBRATION USING PSEUDO INVARIANT CALIBRATION SITES (PICS): TRENDING AND ABSOLUTE

Temporal Trend of L7 ETM+ over Libya 4



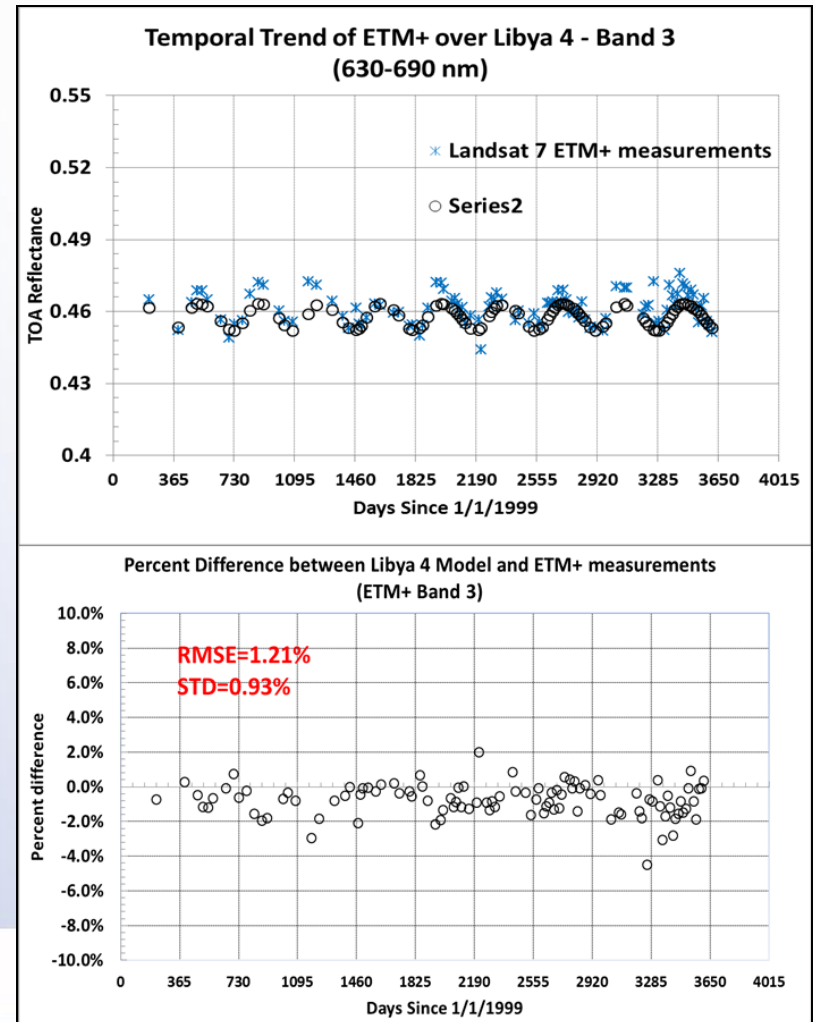
Uncertainties	
Band 1	1.94%
Band 2	1.44%
Band 3	0.95%
Band 4	1.83%
Band 5	1.61%
Band 7	2.75%

t-test on the slope				
Bands	Slope	p-value	Remark	
Band 1	-1.5E-06	<0.0001	Reject	
Band 2	-3.90E-07	0.239	Fail to Reject	
Band 3	-4.81E-07	0.099	Fail to Reject	
Band 4	-1.89E-06	0.004	Reject	
Band 5	-2.97E-06	<0.0001	Reject	
Band 7	-2.86E-06	0.004	Reject	

Degradation per year	
Bands	%/yr $\pm 2\sigma$
	SDSU
1	-0.22 \pm 0.09
2	-0.04 \pm 0.07
3	-0.04 \pm 0.05
4	-0.13 \pm 0.09
5	-0.17 \pm 0.07
7	-0.19 \pm 0.13

Absolute Calibration: PICS-based model

- Absolute calibration can be performed by anchoring trends using a calibrated source or detector
- An empirical model was developed using Hyperion for spectral coverage and anchoring using Terra MODIS. Illumination and viewing geometries, BRDF, and atmospheric corrections were modeled.
- Validation was performed using Landsat 7 with accuracies of $\leq 2\%$ in the VNIR and $\sim 5\%$ in the SWIR.



Objective: Adding atmospheric compensation to improve historical Landsat data calibration

- Historical calibration limited by atmospheric effects
- Use of ancillary data can improve accuracy and precision

LANDSAT DATA CONTINUITY— IMPROVING THE HISTORICAL RECORD CALIBRATION



Landsat data continuity—improving the historical record calibration

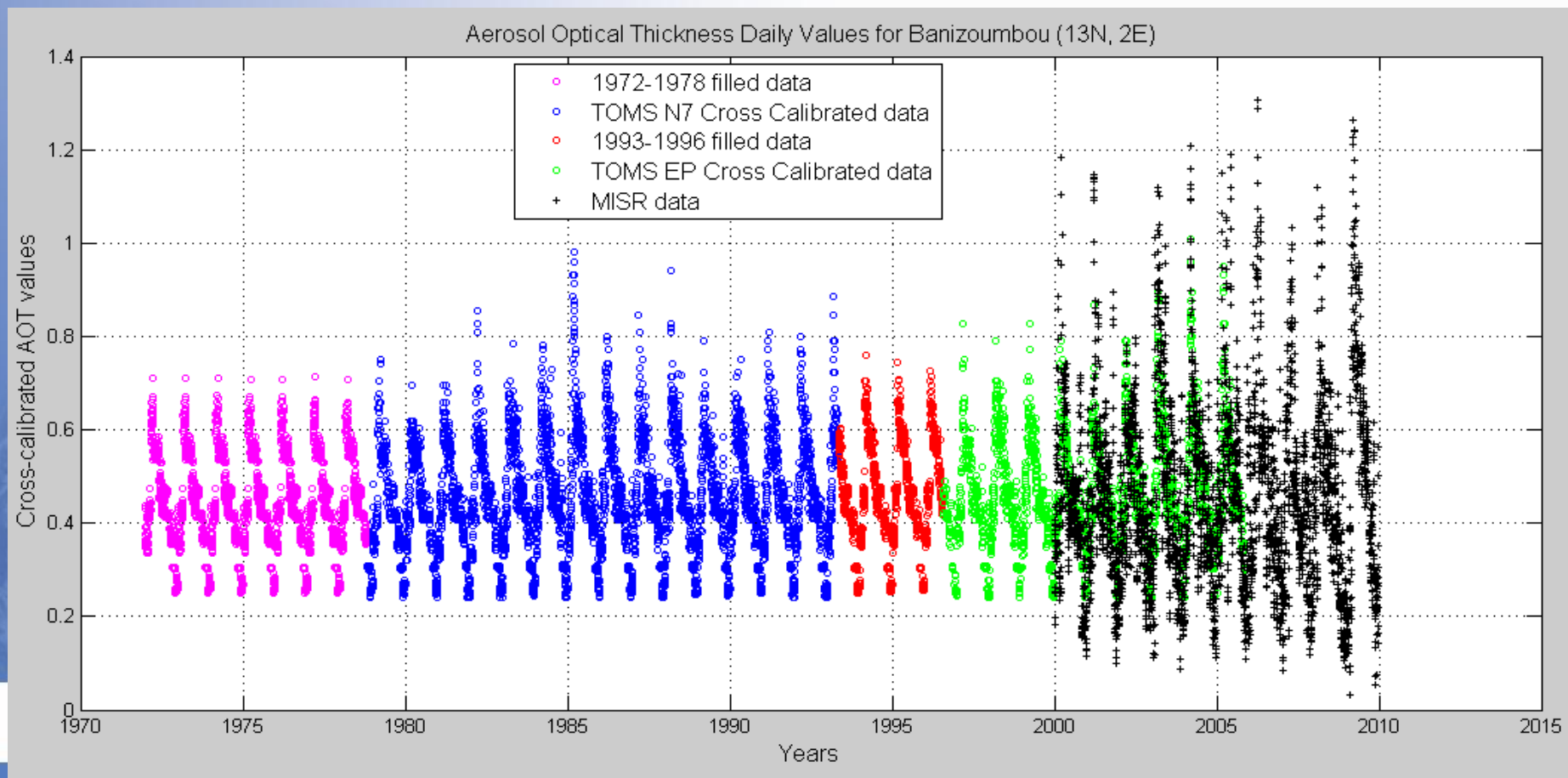
- Aerosol
 - Affects Bands 1,2 & 3 with decreasing intensity
 - Water vapor
 - Affects Bands 5, 7 & 4 with decreasing intensity
 - Ozone
 - Affects Bands 2 and 3 with decreasing intensity
- All Aerosol (MISR/TOMS) data ingested
 - Processing in Progress
 - All NOAA data is ingested (water vapor key)
 - No further processing needed
 - All OMI / TOMS Ozone ingested
 - Processing in Progress

With these 3 atmospheric effects causing most of day to day variability and affecting all bands to some level they become the key components to estimate.



Inputs – Aerosol: Example

- Test case example for Aerosol from 1972 - Present



Summary/Conclusions

- Happy to be a part of the Landsat Science Team
- Looking forward to working with exceptional new and 'old' instruments
- Looking forward to working with exceptional 'new' and 'old' people, too!
- Imperative for this team to do two things:
 - Clearly proclaim the value of the Landsat mission
 - Provide solid science input to the long term requirements of the Landsat mission

